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Title
The efficiency of four transtibial suspension systems: A malformation case study.

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Summary
This work was developed in the form of a case study to measure the efficiency of gait and conclude if the tested suspension systems differ in the efficiency in a various tested transtibial prostheses,based on the data provided by radiologic images, indirect calorimetry and perception of the patient.

Introduction/Basis
The suspension system and the stump adjustment to the socket plays an important role in the functionality of the prosthesis, the mobility of the amputee and overall satisfaction with the device. The comfort and functional effectiveness of the prosthesis are closely related2.
The harmony between the residual limb and prosthesis is crucial to that this meets its function and enable effective March and allow the amputated the continuity of their Daily day activities, keeping the stump functional.
Comfort and functional effectiveness of the prosthesis are closely related, suspension systems should prevent excessive longitudinal and rotational transverse displacement of the stump within the socket, these systems should help stabilize and enhance the connection of the prosthesis to the residual limb, reducing the pistonning, increased proprioception and providing a more natural gait.

Scientific Method
The Functional performance that each suspension system allows will be addressed by analyzing qualitative and quantitative variables. In the qualitative approach, the first instrument to use is Medicare Functional Classification Level (MFCL), which serves to quantify, in the initial phase of the study, the functional potential of the subject under study, and in a second phase of the study the other instrument that will be used is the Prosthesis Evaluation Questionnaire

(PEQ), that will serve to analyze the perception of the subject, as the functionality and quality of life provided by each of the prostheses tested.

In the quantitative approach, we will apply different tested protocols, which will quantify the variables of longitudinal displacement in a study – piston and gait efficiency. For this tests the patient were provided of four prosthesis with four suspension systems, a hypobaric membranes suspension system, a PIN system, a suction valve with knee sleeve and de VASS system.

Implementation

The analysis was done using the various quantitative dependent variables under study: the plunger; and the efficiency of the March with the values of the distance in meters (m); speed (m/min); energy consumption-Vo2max in each landing (ml/Kg/min); energy cost (ml/Kg/m).

Of four the systems studied with the application of PEQ result that the more satisfying prosthesis to the subjected was the prosthesis whit the vacuum assisted suspension system (VASS). From the analysis of the variables of gait efficiency resulted that the most functional prosthesis was the one with vacuum assisted suspension system (VASS). The results obtained by imaging systems have enabled only 3 piston values since one of the systems does not create sufficient suspension to support the weight placed on the distal end of the prosthesis. Through measurements on imaging studies of the three systems we find variations of piston effect ranging from 47,91mm to 72,55mm (Table 1).

For the pistonning, the radiology studies showed a different range of values. In the case of the prosthesis with hypobaric membranes, the results are not presented because during the test it was found that the system was not a suspension needed to perform the test with the 5 kg, however this value to be possible to obtain it would always be more than 72, 55 mm. In other tests we found values between 47, 91 mm and 72, 55 mm, as can be seen in table 2.

Conclusion

Through the realization of the study there were found differences in the test results of the various suspension systems, proving that this is a viable tool in the evaluation. Also through the analysis of the results was clear that the VASS suspension system is the one that provides greater functionality and satisfaction to the amputee.

Given that the system of suspension and adjustment of prosthetic socket, plays an extremely important role in the functionality of the prosthesis, the mobility that the amputee reaches with its use and satisfaction of the same, we can say that on the basis of the results obtained the best solution for this individual is the suspension system VASS.

Although this case study cannot be extrapolated to the general population, by being a case study and the specificity of it, serves as proof that there are significant differences with regard to the variables being studied in different prosthetics transtibiais suspension systems and that this methodology can be replicated in every patient in order to determine the most appropriate solution for each case.

References

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Image: Table 1 and 2_1887.png

		Hypobaric Membranes Suspension System		PIN system		Suction valve with knee sleeve		VASS system			
		VO_2 ml/min/Kg	Efficiency ml/Kg/m	VO_2 ml/min/Kg	Efficiency ml/Kg/m	VO_2 ml/min/Kg	Efficiency ml/Kg/m	VO_2 ml/min/Kg	Efficiency ml/Kg/m	Distance Walked	VO_2±DP ml/Kg/m
Velocity (m/min)	Time (min.)	By step	By step	By step	By step	By step	By step	By step	By step	By step	By step
0	0	4,84		8,08		7,69		8,07			7,17±2,33
53,64	0/4	14,34	0,27	11,68	0,22	14,65	0,26	14,37	0,27	211±9m	14,66±1,36
67,05	04-ago	15	0,22	16,04	0,24	14,45	0,22	17,19	0,26	478±3m	14,72±2,47
80,46	8/10,30	15,7	0,2	16,18	0,2	17,58	0,22	16,13	0,2	712m	16,40±1,18
80,46	08-dez	16,12	0,2			16,88	0,21	18,61	0,23	799±9m	17,20±1,41
93,87	12/12,45	17,15	0,18			18,64	0,2	17,79	0,19	882m	16,42±2,22
93,87	12/13,30	18,71	0,2					18,38	0,2	939m	18,55±0,09
93,87	12/15,30							18,46	0,2	1102m	19,29
107,28											

Table 1. Comparison between O2 consumption efficiency and distance walked

Suspension System	With 5 Kg of traction	Without traction	Pistonning
Hypobaric Membranes Suspension System	NS	NS	NS
PIN system	101,26mm	47,58mm	53,68mm
Suction valve with knee sleeve	124,88mm	52,33mm	72,55mm
VASS system	106,87mm	58,96mm	47,91mm

Table 2. Pistonning with the diferent suspension systems